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GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

RESEARCH PROJECT INITIATION

Date: November 11, 1975

Project Title: Controlled Landfill Stabilization by Leachate Recycle

Project No: E-20-677

Principal Investigator: Dr. F. G. Pohland

Sponsor: U. S. Environmental Protection Agency

Agreement Period: From 8/26/75 Until 8/25/77

Type Agreement: Grant No. R 803953-01

Amount: $25,000 EPA
4,600 GIT
$29,600

Reports Required:
Quarterly Progress Reports; Final Report

Sponsor Contact Person (s):

TECHNICAL MATTERS

Mr. Dirk Brunner
Project Manager
Municipal Environmental
Research Laboratory
Environmental Protection Agency
Cincinnati, Ohio 45268
(513) 684-4487

CONTRACTUAL MATTERS
(Thru OCA)

Grants Officer
Environmental Protection Agency
Grants Administration Division
401 M Street, S.W.
Washington, D. C. 20460

Assigned to: Civil Engineering

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RA-3 (9-75)

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: 9/20/77

Project Title: Controlled Landfill Stabilization by Leachate Recycle.

Project No: E-20-677 Continued as separate project

Project Director: F. G. Pohland

Sponsor: Environmental Protection Agency

Effective Termination Date: 2/25/77

Clearance of Accounting Charges: 2/25/77

Grant/Contract Closeout Actions Remaining: NONE

_ Final Invoice and Closing Documents
_ Final Fiscal Report
_ Final Report of Inventions
_ Govt. Property Inventory & Related Certificate
_ Classified Material Certificate
_ Other _____

Assigned to: Civil Engineering (School/Laboratory)

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CA–4 (3/76)

Quarterly Progress Report No. 1
"Controlled Landfill Stabilization by Leachate Recycle"
EPA Grant No. R 803953-01
Research Project E-20-677
August 26, 1975-November 30, 1975

In accordance with the objectives and research schedule provided in the grant application and award statement, preliminary plans have been made to construct two prototype landfill cells on the Georgia Tech campus which will supplement previous data obtained on leachate recirculation for accelerated stabilization and leachate treatment. Particular emphasis will be placed on recording mass flux as determined by analyses on the quantity and quality of materials emanating in the liquid and gas phases from the landfill cells as a consequence of exposure to rainfall or rainfall equivalent in the Atlanta area. Shredded municipal refuse with sludge additions will be used as the basic solid waste material in each cell. One cell will be open at the surface to permit the influx of rainfall; the other will be closed and receive liquid input consonant with rainfall and thereby permit also a determination of quantities of gas produced and impact of possible evapotranspiration on total liquid (leachate) quantities to be handled.

Because of the delay in receipt of an approved budget until mid-November, the cells have not been constructed to date but the site has been selected and approved for use. Moreover, liner options have been reviewed and alternatives explored with the manufacturers. Necessary appurtenances have been identified and analytical capabilities scheduled so that immediate progress can be achieved once the units have been constructed and become operational. Construction plans are presently being formulated and it is anticipated that construction will be completed during the next quarter barring unforeseen delays.

As requested in the award statement, information and data are being compiled to provide a conceptual evaluation of the system including extent of application and some economic comparisons with other solid waste management techniques. Much of this effort should also be completed by the end of the next quarter.

Frederick G. Pohland
Project Director

Quarterly Progress Report No. 2
"Controlled Landfill Stabilization by Leachate Recycle"
EPA Grant No. R 803953-01
Research Project E-20-677
Georgia Institute of Technology
December 1, 1975-February 29, 1976

In accordance with the objectives and research schedule provided in the grant application and award statement, the final plans for development of two prototype landfill cells on the Georgia Tech campus have been formulated and approved and bids are being solicited for basic construction of the containment structure. In addition, bids have been received for the liners to be used to seal the units and commercial prefabrication of the liners to fit the cells is presently proceeding.

Because of increased costs associated with changes in construction details from basically timber to reinforced concrete/block containment to provide better structural integrity and opportunity for more reliable sealing of the test cells, it was necessary to reduce the size of the units from a 12' x 12' x 10' to a 10' x 10' x 10'. This reduction in capacity should not adversely effect ultimate research results and was instigated as an economy measure. However, the original cost estimates and budget were still not sufficient to accomodate construction and it was necessary to officially request additional support from the granting agency. Approval of such additional support should be forthcoming from the sponsor and in time to initiate construction without unnecessary delays.

In spite of the scheduling problems incurred by delayed approval of the initial grant award and by recent changes in construction approach, it is anticipated that the test units will be made operational and preliminary

results will be made available during the next quarter of the project period. Moreover, collection of information and data relating to the application and feasibility of leachate recycle as a solid waste management alternative is being completed and a presentation of some of these findings will be made at an engineering institute at the University of Wisconsin in Madison on "Gas and Leachate Generation and Control in Landfills" scheduled for March 29-31, 1976.

Frederick G. Pohland
Porject Director

E-20-677

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

SCHOOL OF
CIVIL ENGINEERING

TELEPHONE:
(404) 894-2265

June 15, 1976

Mr. Dirk Brunner, Project Manager
Municipal Environmental Research Laboratory
Environmental Protection Agency
Cincinnati, Ohio 45268

Dear Dirk:

Enclosed find five copies of our third quarterly progress report on project R 803953-01, "Controlled Landfill Stabilization by Leachate Recycle" (E-20-677) covering the period March 1, 1976 through May 31, 1976. Since receipt of the additional funds to accomodate increased cost of construction of the test cells, progress has been made toward preparing the cells for the research investigations. We have been set back in our schedule by delays in construction which we hope to adjust to by the recently approved extension of the initial budget period to February 25, 1977.

I appreciate your continued support of this endeavor and will advise you when we are ready to fill the units with refuse.

Best regards.

Sincerely,

Frederick G. Pohland
Professor of Civil Engineering
Project Director

Encl.
cc: Mr. K. E. Newkirk, ORA
Dr. J. E. Fitzgerald, CE

Quarterly Progress Report No. 3
"Controlled Landfill Stabilization by Leachate Recycle"
EPA Grant No. R 803953-01
Research Project E-20-677
Georgia Institute of Technology
March 1, 1976 - May 31, 1976

In accordance with the objectives and research rationale provided in the grant application and award statement, construction of the prototype landfill cells on the Georgia Tech campus has been initiated during this project period. The containment structure of reinforced concrete/block construction has been completed and sealed with two coats of "Scotch Kote" Brand 302 protective coating. Some delay was experienced in the receipt of this material, but because of its unique protective features, this coating was substituted for the original choice which delayed receipt and application.

The leachate receptor sumps have also been placed into location and the external drainage system is being placed. In addition, the protective insulation for the cells have been received together with the liners. Once in place, necessary appurtenances will be installed and the cells made ready for receipt of the refuse to be used in the experimental studies. It is anticipated that the cells will be placed into operation during the next project period thereby allowing for accumulation of experimental results sufficient to satisfy the project objectives proposed to be fulfilled during the initial project phase.

During this project period, additional funding and a 6-month extension to the first project phase were requested and granted to accomodate some of the unforeseen delays and cost overages associated with construction of the test units.

Frederick G. Pohland
Project Director

Quarterly Progress Report No. 4
"Controlled Landifill Stabilization by Leachate Recycle"
EPA Grant No. R-803953-01
Research Project E-20-677
Georgia Institute of Technology
June 1, 1976-August 31, 1976

In accordance with the objectives and research rationale provided in the grant application and award statement, construction of the containment structure for the simulated landfill cells has been completed and the shredded municipal refuse from DeKalb County Georgia has been placed into the cells, compacted and, for the covered cell, sealed with the liner. Appurtenances for gas collection and leachate distribution are being constructed and initial refuse characterization is being completed.

The shredded refuse was received by compactor trailer on August 11, 1976 from the DeKalb County Shreading facility. The test material was specifically chosen to be as representative of residential refuse as possible and preliminary evaluations of its characteristics has confirmed this fact. The refuse was added to the two test cells alternately in 2-foot layers with each layer being hand compacted with a tamping device between layers. After filling, the totally lined cell contained 8.5 feet of compacted refuse; the open cell contained 9.0 feet of compacted refuse. The density of the compacted refuse in each cell averaged 537 pounds/cu.yd. The redistribution system was placed at the top of the compacted refuse and the distribution box and laterals were encased in loose gravel prior to adding 2 feet of cover soil.

The process of filling and sealing the cells required about three days effort during which time 0.12 inch of rainfall occurred. Since the covered cell has been sealed an additional 0.5 inch of rainfall has accumulated but no leachate production has commenced. Some initial settling has been observed in the open cell which appears to be uniformly occurring across the entire surface area.

Additional analytical data on refuse characterization, source and settling properties will be accumulated during the next project period. In addition, gas quality and quantity will be closely monitored to determine possible biological activity and test the integrity of the closed cell against leaks. Temperature will also be monitored during this period and an experimental routine established.

Frederick G. Pohland
Project Director

E-20-677

Delft. University of Technology

Department of Civil Engineering

Mr. Dirk Brunner, Project Manager
Municipal Environmental Research Laboratory
Environmental Protection Agency
Cincinnati, Ohio 45268
U.S.A.

Your reference	Your letter of	Our reference	Delft, Oceanlaan/Stevinweg 1	telephone 015-133222
			November 23, 1976	

Re: R-803953-01

Dear Dirk:

I am enclosing herewith five copies of our fifth quarterly progress report on project R-803953-01, "Controlled Landfill Stabilization by Leachate Recycle" (E-20-677) covering the period September 1, 1976 through November 30, 1976 a few days early because of the time delay for receipt of mail between here and the United States. This will not detract from the contents of our report since I have included that information I personally accumulated during my October visit as well as what I have received by mail since.

I am afraid I did not appropriately anticipate some of the problems with interchange of information between the Delft and Georgia Tech. Normally, if everything goes well, I can get answers back in two weeks. However, on occasion, some information will be missing which then requires a repeat of the process. We hope to have this interchange down to a more satisfactory routine shortly, but it has delayed my preparation of the renewal proposal which was magnified this time by the critical illness of Jim Hudson's mother and his absence from Tech over the past two weeks. As a consequence, we will unfortunately not be able to meet the November 25, 1976 date for receipt of the renewal proposal indicated by correspondence attached to the application kit by Mr. Frederick Meadows. I hope the circumstances this time will give us some grace; it is somewhat frustrating to be held up by the mails and the inconvenience of isolation by distance.

November 23, 1976

Please be assured that this delay does not reflect problems with the project administration at Georgia Tech; it is very well manned by the team of Jim Hudson, Wendall Cross (both of whom you met in Atlanta), and by a new post-M.S. student, Khaliquc Kahn. In fact I have assurances that information requested for preparation of the proposal will be forthcoming and that no problems exist except perhaps expediting the normal process of proposal administration and acquiring necessary signatures at Georgia Tech. Moreover, with some additional time we can better document and justify continued efforts on the project. Therefore, we would appreciate your understanding and cooperation on this issue and trust that the delay will not hamper normal transition into the new project period. In addition, if I need to contact the EPA Grants Operation Branch (Meadows) to explain the delay, please let me know.

My Netherlands experience continues to be rewarding and I intend to use much of a holiday break to attend to my responsibilities relating to the analysis of the applicability of the leachate recycle system to solid waste management practices as originally requested in the grant award. Because of the dearth of real information, I'm afraid much of this will need to be presumptive at this time but hopefully at least an educated guess. As the project progresses, I'm sure we will be able to better substantiate some of the estimates which may appear. I am also developing an itinerary of places and people I will want to visit while I am here that relate to this research and solid waste management attitudes in general. Of course, I am still interested in your support of this, but that issue can be deferred until the present matters have been resolved.

It was certainly good to see you, if only briefly, in Minneapolis. It seemed that my trip was all too short for all the things I tried to accomplish. I will try to return again in March to pick up where I left off and to look after the project developments hopefully in a new budget period. In any event, I will keep you informed and also send you a copy of the continuation proposal when it becomes available.

Best personal regards.

Sincerely,

E.G. Pohland
Professor of Civil Engineering
Project Director

cc.: Mr. K.E. Newkirk, ORA

Quarterly Progress Report No. 5

"Controlled Landfill Stabilization by Leachate Recycle"

EPA Grant No. R-803953-01

Research Project E-20-677

Georgia Institute of Technology

September 1, 1976 - November 30, 1976

In accordance with the objectives and research rationale provided in the original grant application and award statement, the simulated landfill cells have been operated and monitored since filling with municipal refuse during the period August 11-13, 1976. Installation of the leachate and gas distribution/collection systems has been completed for each cell and checked for operational reliability and eventual sampling capabilities. The leachate distribution system for the closed cell has also been operated to deliver tap water by pumping an amount equivalent to the periodic rainfall received by the open cell. In addition, the piping system originally conceived to serve for both gas collection and leachate distribution in the closed landfill cell has been augmented by a separate gas collection system consisting of six, one-inch diameter, perforated PVC pipes placed vertically to a refuse depth of four feet from the surface and interconnected above the cover soil and beneath the Hypalon lining at the top, thereby serving also as a internal liner support structure. A valved lateral connected to this network will permit separate gas collection and measurement when gas is produced. Additional tubing to accommodate temperature probes, inserted into the refuse in each cell, have been connected to a continuous monitor. Both rainfall and relative humidity are also being measured by on-site instrumentation.

In order to exclude rainfall and protect the liner at the surface of the closed cell, a sloped, waterproofed plywood roof has been constructed and installed over the top of the closed landfill cell. Moreover, to exclude wind-blown rain, an impervious protective matting has been attached to the roof and draped over the sides of the landfill cell. In both cells, the space between the liners and the walls of the cells have been either covered or sealed to prevent seepage along the walls to the lower underdrain systems.

Analyses on the average characteristics of the municipal refuse placed in each of the landfill cells have been completed as indicated in Table 1. In addition, routine monitoring for relative humidity, temperature and rainfall have provided the data included in Table 2.

Table 1

Characterization of Refuse Used to Fill Simulated Landfill Cells

Parameter	Average Analysis*
Density, lbs/cu.yd	537
Moisture Content, %	33.5
Total Volatile Solids, % dry	75.5
Hydrogen, %	5.46
Nitrogen, %	3.33
Carbon, %	45.3
Heat Value, Btu/lb.dry	7758

* on six samples collected periodically during the filling operation

Table 2

Rainfall, Temperature and Humidity Measurements from Operation of the Simulated Landfill Cells

Date	Rainfall, inches	Cumulative Rainfall, inches
8/23/76	0.110	0.110
8/26/76	0.650	0.760
8/27/76	0.275	1.035
8/30/76	0.010	1.045
9/2/76	0.110	1.155
9/5/76	0.425	1.580
9/10/76	0.110	1.690
9/15/76	0.090	1.780
9/21/76	0.220	2.000
9/23/76	0.020	2.020
9/27/76	0.100	2.120
9/28/76	0.050	2.170
9/29/76	0.060	2.230
10/6/76	0.180	2.410
10/7-8/76	1.030	3.440
10/9/76	0.425	3.865
10/17/76	0.410	4.275
10/20/76	0.420	4.695

Weekly Relative Humidity: Day; 70%, Night; 76%

Weekly Temperatures

Ambient: Day; 27°C, Night; 10.3°C

Cells : Open; 28.9°C, Closed; 32.0°C

About 250 gallons of rainfall or rainfall equivalent had been received by the cells during this period without detection of either leachate or gas production. This pattern has been duplicated to date and the rainfall received or added as tap water to the cell has now increased to about 500 gallons without the production of leachate or gas. Some temperature differential between ambient and that within the cells was noted, however, with the closed cell exhibiting the higher recording. Whether this was do to insulation or some initial aerobic activity could not be determined at this time. In addition, about five more inches of compaction of the open cell has been measured over the initial depth of 9.0 feet of compacted refuse.

Observations and analyses on rainfall, temperature and relative humidity variations, and possible increased settling will be continued during the next phase of the project period. In addition, if leachate and/or gas accumulations or changes in composition occur, routine comprehensive analyses will be initiated. The final phase of the present project period will also be used to prepare an evaluation of the potential applicability of the leachate recycle concept and to organize the data to be included in the final report for the project period.

Frederick G. Pohland
Project Director

E-20-677

Quarterly Progress Report No. 6

"Controlled Landfill Stabilization by Leachate Recycle"

EPA Grant No. R-803953-01

Research Project E-20-677

Georgia Institute of Technology

December 1, 1976-February 28, 1977

In accordance with the objectives and research rationale provided in the original grant application and award statement, the simulated landfill cells have been operated and monitored since filling with shredded municipal during the period August 11-13, 1976. In addition, a continuation proposal has been prepared and submitted to the granting agency (EPA) to provide support for a second project period extending from March 1, 1977 through February 28, 1978. The research progress detailed in previous quarterly progress reports have been reviewed and presented collectively in this application together with a project plan for the new project period.

Since neither the open or closed cells have reached field capacity, monitoring efforts during this report period were concentrated on the determination of possible changes in internal and external environment conditions. Accordingly, records on temperature, relative humidity, and precipitation have been extended from the initial sampling period and summarized by weekly average as illustrated in Figures 1 and 2 attached. The variations between high and low ambient as well as cell temperatures are representative of normal diurnal and seasonal patterns for the period of observation with the exception that unusually cold weather occurred from December into February. The decline in ambient temperature was generally paralleled by a similar decrease in cell temperatures with the closed cell initially exhibiting higher temperatures than the open cell. This temperature relationship was reversed, however, toward the end of the report period when the internal temperature of the closed cell became lower than that of the open cell. It is believed that this was attributable to the freezing conditions and the manner in which equivalent rainfall was added during this period. It is expected that the internal temperatures will stabilize in both cells and then fluctuate in a more predictable fashion both daily and seasonally.

As illustrated in Figure 2, the variations in relative humidity have been reasonably constant and related to rainfall events and temperature but with a very dry period during the coldest temperatures. Incident rainfall is approaching 20 inches which is yet insufficient to permit either cell to reach field capacity. However, some leachate has appeared in the closed cell which may have resulted as a consequence of short-circuiting as water equivalent to rainfall was added through the recycle distribution system. This may have been promoted by the freezing con-

ditions, but of more serious consequence, the accumulation of some of this liquid in the underdrain system during the cold weather conditions apparently led to ice formation and rupture of the integrity of the liner or the seal between the liner and the pipe network. Therefore, liquid has appeared in the drainage system below the liner which signifies loss of the seal and ability to safeguard against future escape of gas from the closed cell.

Although the loss of system integrity is unfortunate, it has apparently occurred before rapid stabilization processes have commenced since no measurable gas production could be detected before the incident and gas analyses in both the head space between the top of the cover-soil and the surface liner and in the distribution system have shown little change over the past few months. The head space has been devoid of CO_2 or CH_4, containing normal air constituents; the oxygen content in the distribution system has decreased within the past month from 11.9% to 8.6% with a corresponding increase in CO_2 from 10.3% to 12.8% without any CH_4 being detected. The relative lack of moisture and low temperatures would not be conducive to active biological stabilization so that these results are not surprising. However, as more moisture is added and temperatures increase, this process should accelerate with a more rapid and distinguishable change in gas composition. Therefore, it has become imperative to re-establish the integrity of the closed cell without delay.

To try to locate the position of rupture of the closed cell lining has been considered with the conclusion that it would be a very difficult and expensive task without any guarantees against interfering with the normal processes within the cell. Therefore, it has been decided to close off the lower drain during normal operations and provide an additional surface seal. Several methods have been considered, but it is likely that the seal will consist of a steel plate, placed on the top of the containment structure of the closed cell, and bolted down against a sealant. The leachate recycle and gas collection systems, temperature probes, and inspection manhole would be inserted through this plate and sealed to make gas-tight. Present efforts are being directed toward design and construction of this system and acquiring supplementary support to permit its immediate installation.

Additional effort was also expended during this report period on the accumulation and catagorization of available information supportive of a rationale for application of the leachate containment-recycle concept to practice. Unfortunately, much of this information is difficult to interpret within this perspective and little reliable operating experience is available. Therefore, it has not yet been possible to develop a position paper in a sufficiently comprehensive manner to with stand the rigors of professional scrutiny and critique. However, a framework has been established to which it is hoped to add sufficient supporting documentation to permit completion of this task within the next project period.

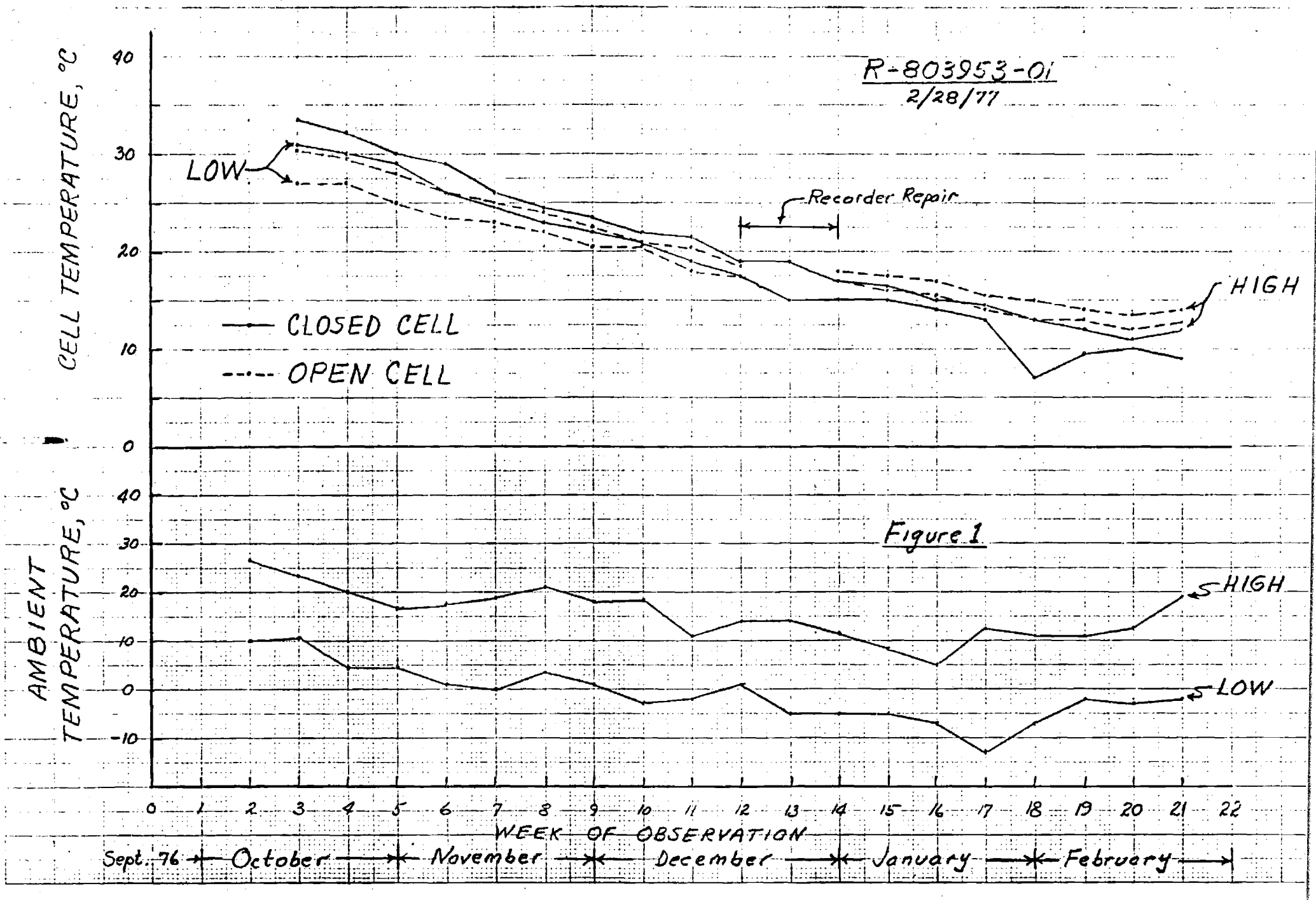
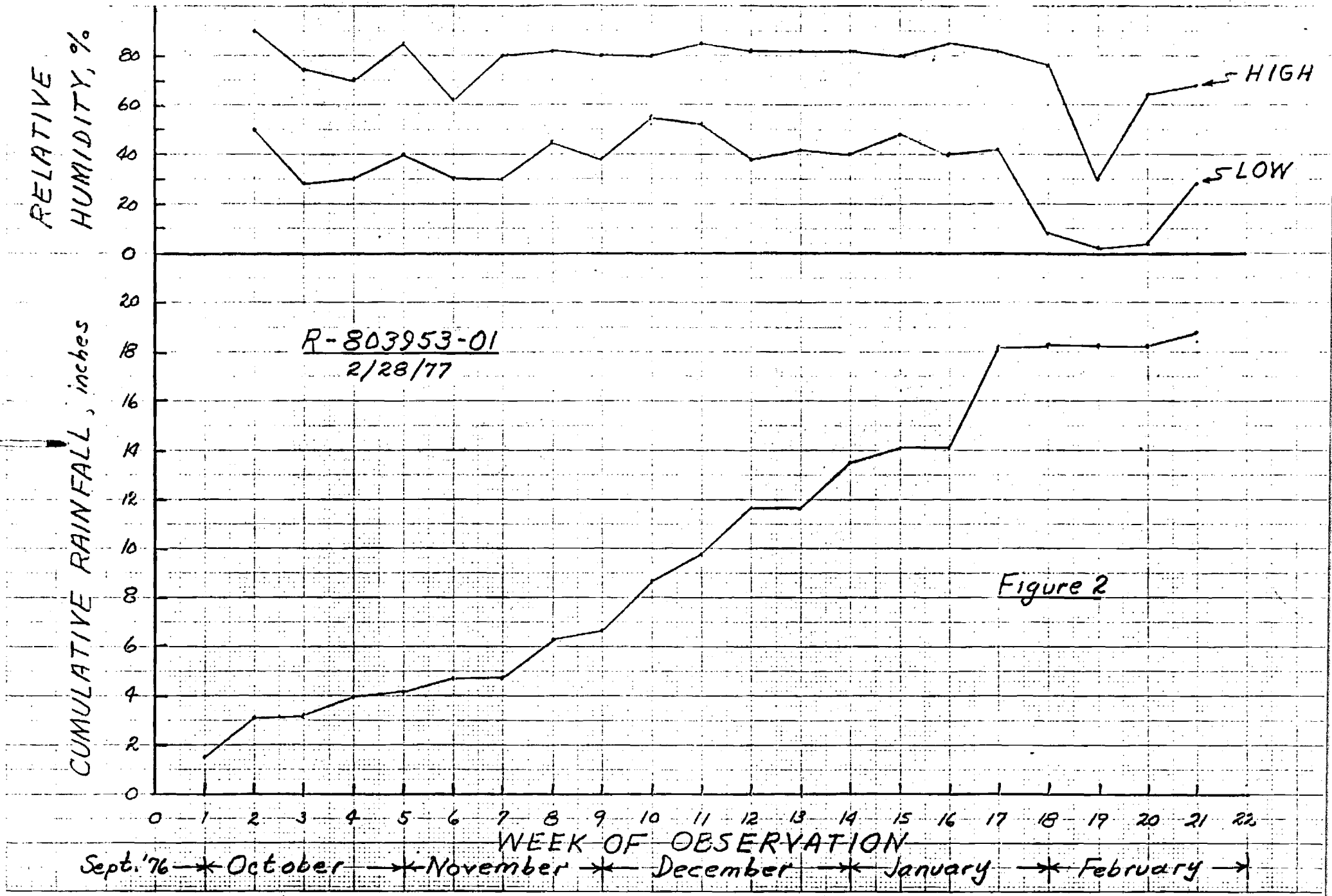

R-803953-01
2/28/77
CELL TEMPERATURE, °C
40
30
20
10
0
LOW
HIGH
Recorder Repair
CLOSED CELL
OPEN CELL
AMBIENT TEMPERATURE, °C
40
30
20
10
0
-10
HIGH
LOW
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
WEEK OF OBSERVATION
Sept. '76
October
November
December
January
February

Figure 1


RELATIVE HUMIDITY, %
80
60
40
20
0
HIGH
LOW
CUMULATIVE RAINFALL, inches
20
18
16
14
12
10
8
6
4
2
0
R-803953-01
2/28/77
Figure 2
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
WEEK OF OBSERVATION
Sept. '76
October
November
December
January
February